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Design of JIB Crane 600 kg Electric Powered

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Abstract—As it is known that the construction of high-rise buildings requires a tool in the form of a JIB Crane, which is used to transport materials from the bottom to the top. This JIB Crane is installed at the top of the tall building. In this case to design this tool requires welding and also a hook that is able to withstand the load being transported and moved. In this plan, the material must be chosen and also careful calculations for certain parts such as welded joints. In this study, a JIB Crane was designed with an electric drive to carry a load of 600 kg. And based on the calculations obtained, the load supported by the construction of the JIB Crane design is able to withstand the load where the load from the design is greater than the load that occurs.

Keywords: building, electric, crane, tall

1 Introduction

THe constructing high-rise buildings such as: multi-level buildings, machines are needed to help and ease the work of humans themselves. In connection with this, it is necessary to have a lifting machine that can lift and move building materials and structures that will be installed on the building being worked on with safe motion and mobility. So that the material being lifted remains good, safe in loading and unloading operations more quickly, it is necessary to have a container of goods that can be lifted from all project areas to the desired place such as a bucket. To lift material in maximum lifting capacity, reach and height, lifting with JIB Crane is the most effective machine. The tendency to use tower cranes is currently getting higher along with the increasing development. Material transfer machine is a material transfer machine used to move cargo in locations or areas, departments, factories, construction sites, storage areas, unloading cargo, and so on. In contrast to long-distance transport (trains, cars, by water, and air) which move cargo over considerable distances, confectionary equipment moves cargo over much shorter distances. In its application the distance traveled is only limited to tens to hundreds of meters. Distances of thousands of meters are only occasionally carried out to ensure constant transfer of cargo between two or more sites connected by the same production activity. In loading and unloading operations within a factory, the moving facilities are divided into interdepartmental loading and unloading facilities and interdepartmental loading and unloading facilities. The transport facilities can be divided into external and internal area in the construction site [1].

The crane is one of the heavy equipment (heavy equipment) that is used as a lifting tool in construction projects. The cranes work by lifting the material to be moved, moving it horizontally, then lowering the material in the desired place. This tool has a great shape and lifting power and can rotate up to 360° and a range of up to several tens of meters. In addition, this type of crane is also suitable for placing in workstation areas that allow repeated lifting such as warehouses, docks, building construction and workshop areas. The design of crane requires computer software. The use of this computer software has been widely used by previous researchers.

Many researchers have applied the computer application such as pro engineer, Inventor, Catia, etc., to calculate the designing process. Wang et.al applied the Moldex to determine the molding manufacturing process of LED, micro gear, and the blu ray lens [2], [3], [4], [5]. Arifin et.al and Nofarika et.al. applied Autodesk Inventor to calculate the von mises stress, deflection and safety factors in the designing vise with the 45^{o} angle and the fixture of fire kit [6], [7]. Kamal et.al and Irawan et.al determined the strength of wind turbine using solid work software [8], [9]. Then, Germana et.al.[10] and Fauzi et. al. [11] studied the combination Savonius and Darrius wind turbine by applying the solid work software to analysis the CFD.

Moreover, in the designing of the JIB Crane have to consen about the strength of this equipment. The purpose of this study to get the best designing of the crane, that is able to solve the problem in designing process of crane.

2 Research Method

The method used in the design of JIB Crane is an analytical method to calculate the strength of the design results by calculation and using software, while to analyze and identify possible failures in the designing process [12].

The research start by collecting the important information about the carne, especially in construction design. Information is collected from various sources, such as the journal article, literature, and finally the field of research. Then, the design is analyzed the strength of the frame construction and the overall circuit calculation and using software.

The following is a flowchart of the design and construction of welding fittings for the production of JIB Crane (Figure 1).

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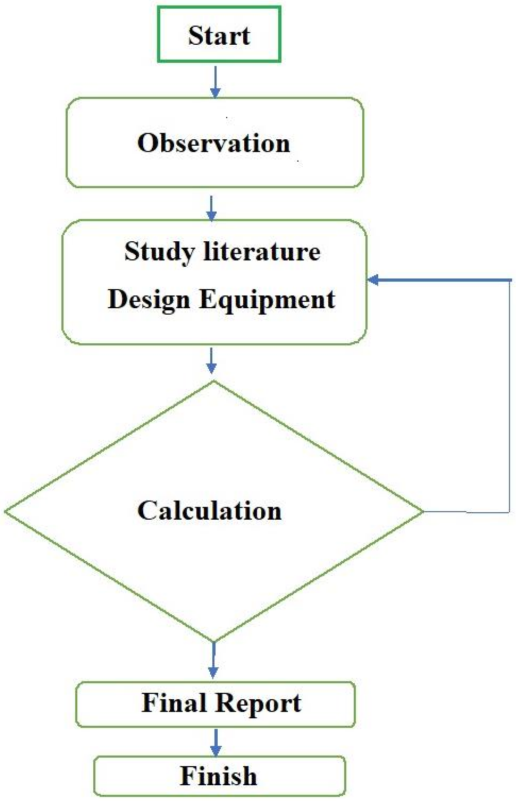


Fig 1. Research flow chart

2.1 Analysis Load Welding Calculation

The construction of the JIB crane is welded, so in this part the welding calculation become important. It can be calculated using the following formula [13]:

Weld Cross-sectional Area

$$A = 2 \text{ x } \frac{t \ x \ l}{\sqrt{2}} \quad \text{..........................} \quad (1)$$

Shear stress

$$\tau_g = \frac{F}{A} \quad \text{..........................} \quad (2)$$

Shear stress permission

$$\sigma_{t\,(i)} = \frac{\sigma t}{sf} \quad \text{..........................} \quad (3)$$

$$\tau_{g\,(i)} = \frac{\sigma t(i)}{2} \quad \text{..........................} \quad (4)$$

Welding Length

$$L = 2 \text{ x } l \quad \text{..........................} \quad (5)$$

Welding Thickness

$$t = \sin 45^o \text{ x } s \quad \text{..........................} \quad (6)$$

Welding Stress

$$P = A \text{ x } \tau_{g\,(i)} \quad \text{..........................} \quad (7)$$

2.2 Hook Strength

The hook is the first component that is exposed to a direct load from the material being lifted. Therefore, in addition to using the existing specifications from the tackle, the author also performs calculations so that the load received by the hook itself can be determined. The calculation of the stress on the hook is as follows:

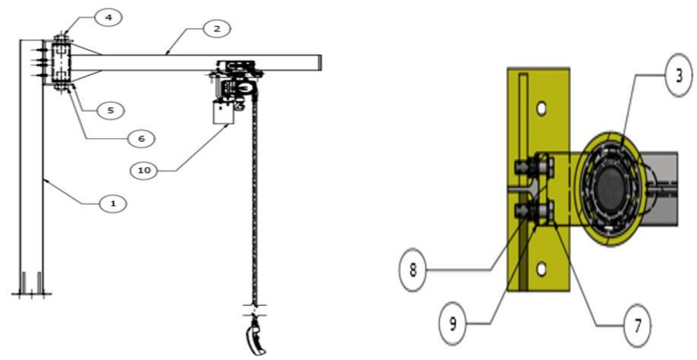
Strength permission $\sigma t\ izin = \frac{\sigma t}{n}$ ……………… (8)

Shear stress $\tau g = 0{,}5 \text{ x } \sigma t\ izin$ …………… (9)

Strength $\sigma t = F/A$ ………………. (10)

3 RESULT AND DISCUSSION

The design construction of the JIB Crane can be seen in figure 2.



1. Crane Structure
2. Crane Arm
3. Bearing
4. Spindel
5. Connecting Arm and Structure
6. Screw M60
7. Bolt M16
8. Screw M16
9. Washer Ø16
10. Chain Hoist

Fig. 2. The design of the Electric JIB Crane

Welding calculation in the part of JIB crane can be seen in the figure 3.

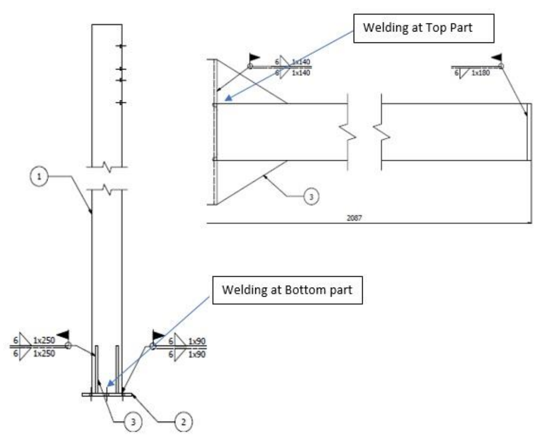


Fig. 3 Welding Position in JIB Crane

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The welding at the top part

$P = 0{,}707 \times s \times s \times 1 \times \tau g$

$= 0{,}707 \times s \times (2.d + b) \times \tau g$

$= 1{,}414 \times 12\ mm \times ((2 \times 12\ mm) + 300\ mm) \times 150\ N/m$

$= 16{,}9 \times 274 \times 150$

$= 694.490\ N$

where the support accept the force is :

$F_{total} = m \times g$

$= 9{,}64\ kg \times 9{,}8$

$= 94{,}4\ N$

So, the $F_{total} \leq P$, that mean the welding is safe to accept the force.

The welding at the bottom part :

$P = 0{,}707 \times s \times s \times 1 \times \tau g$

$= 0{,}707 \times s \times (2.d + b) \times \tau g$

$= 1{,}414 \times 12\ mm \times ((2 \times 12\ mm) + 300\ mm) \times 150\ N/mm^2$

$= 16{,}9 \times 224 \times 150$

$= 567.840\ N$

where, the force accepted by the supporting is:

$F_{total} = m \times g$

$= 9{,}64\ kg \times 9{,}8$

$= 94{,}4\ N$

So, $F_{total} \leq P$, it mean the welding is able to support the force.

3.1 The Hook Design

The design of hook can be seen in figure 4.

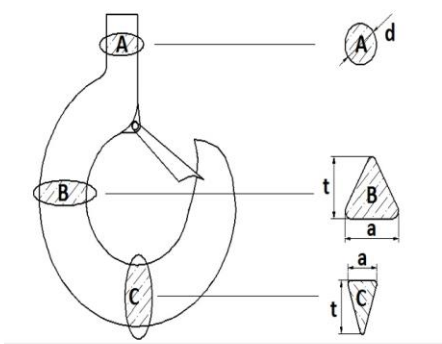

Fig. 4. Design of Hook JIB Crane

Stress on position A

$$\sigma A = 5883 / \frac{\pi.45^2}{4} = 3{,}6\ [N/mm^2]$$

Stress on position B

$$\sigma B = 5883 / \frac{30.50}{2} = 7{,}84 [N/mm^2]$$

Stress on position C

$$\sigma C = 5883 / \frac{20.35}{2} = 16{,}80 [N/mm^2]$$

According material properties of the hook is ST 70 with the Strength 70 N/mm^2, so strength happen is smaller than the material properties, that is mean the hook is safe with the force 16.80 N/mm^2.

4 Conclusion

Basically the working principle and mechanism of this conveyance is to transport heavy objects, making it easier for workers to move goods.

The construction of JIB crane is safe fro the force which is applied in the construction. It can stand with the force 600 kg where the material properties is bigger that the force.

The welding construction is also safe from the force happen in the design construction. The maximum Von Misses stress that occurs in JIB Crane at the top of the Crane connection with a load of 600 kg. Then, The hook can accept or take the load at 600 kg.

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